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logues of the parabasals of the trichomonads. The extranuclear organelles are united with the karyosome, centrosome, and blepharoplast in an integrated neuromotor apparatus. Mitosis is intranuclear, with precocious splitting of the four chromosomes which subsequently fuse in four in the equatorial plate. Free pairs of individuals are found united in back-to-back position as in the so-called conjugation cysts. Nuclei in these cysts undergo two divisions simulating reduction divisions in which, however, chromosomes reduction has not been demonstrated. No evidence in support of autogamy and no proof of sexual reproduction has been discovered.

Morphological characters separate six species in *Giardia*. The parasite in mice appears to be distinct from that in man. The generic name *Giardia* Kunstler should supersede *Lamblia* Blanchard on grounds of priority.

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THE INORGANIC CONSTITUENTS OF ALCYONARIA

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UNITED STATES GEOLOGICAL SURVEY, WASHINGTON

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The zoantharia, madreporaria, or stony corals have been repeatedly analyzed, and with generally concordant results. Thirty analyses, made in the course of the present investigation, of which this paper is a preliminary notice,[1] have confirmed the older data. These corals consist mainly of calcium carbonate, with one or two per cent of minor impurities, and a little organic matter. The same is true of the coralline hydrozoa, of which six analyses, representing the genera *Millepora* and *Distichopora*, have also been made. The alcyonaria, however, which include the red corals, the gorgonias, and other fan-like or branching forms, are quite different; and they are generally characterized by the presence in them of magnesium carbonate, and often of calcium phos-

phate also. Many of them, moreover, are rich in organic matter. To these statements there is one known exception. The blue coral, *Heliopora cerulea*, is an isolated organism, closely resembling the true corals, and like them in its chemical composition.

In the course of our research upon the inorganic constitutents of marine invertebrates, 22 analyses of alcyonarians have been made, representing the following species:

1. *Heliopora cerulea*, Pallas. Blue coral. Southern Philippines.
2. *Tubipora purpurea*, Lamarck. Singapore, Straits Settlements. Latitude 1° 20′ N.
3. *Corallium elatior*, Ridley. A red coral. Murotsu, Tosa, Japan. Latitude about 33° N.
4. *Primnoa reseda*, Verrill. East of Nova Scotia. Latitude 44° 16′ N.
5. *Lepidisis carophyllia*, Verrill. Off Nantucket shoals. Latitude 38° 53′ N. Depth of water 3,168 metres. Temperature 3°. 3′. C.
6. *Pennatula aculeata*, Dana. St. Peter's Bank. Latitude 44° 47′ N. Temperature 4°.5 C.
7. *Paramuricea borealis*, Verrill. Southwest edge of the Grand Bank.
8. *Paragorgia arborea*, Milne-Edwards and Haime. Le Have Ridge, off Nova Scotia.
9. *Alcyonium carneum*, L. Agassiz. Southwest of Stellwagen Bank, off Race Point Light, Cape Cod, Massachusetts. Temperature 3°.9 C.
10. *Gorgonia suffruticosa*, Dana. Fiji Islands.
11. *Gorgonia acerosa*, Pallas. Nassau, Bahamas. Latitude 25°, 5′ 6″ N.
12. *Gorgonia acerosa*, Caesar's Creek, Southern Florida. Latitude about 23° 30′ N.
13. *Muricea humilis*, Milne-Edwards. Parahyba do Norte, Brazil.
14. *Muricea echinata*, Valenciennes. Cape San Lucas, Lower California. Latitude 22° 52′ N.
15. *Plexaurella grandiflora*, Verrill. Mar Grande, Bahia, Brazil.
16. *Ctenocella pectinata*, Valenciennes. Torres Straits, Australia. Latitude about 10° S.
17. *Xiphogorgia anceps*, Pallas, Caesar's Creek, Florida.
18. *Rhipidogorgia flabellum*, Linné, Bermuda. Latitude about 32° N.
19. *Rhipidogorgia flabellum*, Andros Island, Bahamas. Latitude about 25° N.
20. *Leptogorgia pulchra*, Verrill. La Paz, Gulf of California. Latitude 24° 16′ N.
21. *Leptogorgia rigida*, Verrill. Cape San Lucas, Lower California.
22. *Phyllogorgia quercifolia*, Dana. Fernando de Noronha, Brazil. Latitude 3° 50′ S.

The complete analyses of these alcyonarians, which will be published in our final report, show very variable proportions of organic matter.

In Nos. 1, 2, 3, and 5, very little was found; while the others contained quantities ranging from 13 to 61%. Rejecting this variable constituent, and recalculating the inorganic portion to 100%, the reduced or rational analyses assume the following form:

	1	2	3	4	5	6	7	8
SiO_2	0.15	1.40	0.00	0.13	0.11	1.70	0.44	0.15
$(Al,Fe)_2O_3$	0.07	0.57	0.15	0.88	0.05	1.01	0.30	0.03
$MgCO_3$	0.35	12.23	11.56	6.18	6.92	7.71	8.03	9.05
$CaCO_3$	98.93	84.61	86.57	90.39	92.24	85.62	85.11	88.04
$CaSO_4$	0.50	1.19	1.32	1.59	0.68	0.84	4.69	2.17
$Ca_3P_2O_8$	trace	trace	0.40	0.83	trace	3.12	1.43	0.56
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

	9	10	11	12	13	14	15
SiO_2	18.05	0.55	0.22	0.04	0.56	0.11	0.45
$(Al,Fe)_2O_3$	5.80	0.28	0.22	0.24	0.07	0.06	0.15
$MgCO_3$	9.21	13.43	12.52	13.29	12.64	12.28	13.79
$CaCO_3$	52.23	79.84	81.45	79.48	84.47	83.79	85.61
$CaSO_4$	1.36	5.43	1.95	4.08	1.73	2.93	trace
$Ca_3P_2O_8$	13.35	0.47	3.64	2.87	0.59	0.83	trace
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

	16	17	18	19	20	21	22
SiO_2	0.21	0.14	0.21	0.24	0.09	0.28	0.34
$(Al,Fe)_2O_3$	0.13	0.07	0.28	0.07	0.03	0.21	0.26
$MgCO_3$	15.65	13.04	12.64	13.19	13.71	14.13	15.73
$CaCO_3$	81.44	80.96	63.38	80.75	74.99	75.36	72.99
$CaSO_4$	1.69	3.83	2.40	2.95	2.91	2.07	2.11
$Ca_3P_2O_8$	0.88	1.96	1.09	2.80	8.27	7.95	8.57
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Analysis No. 1, of *Heliopora*, might be that of an ordinary coral, being almost non-magnesian and therefore different from all the others. The material of No. 9, *Alcyonium*, was obviously impure, with much admixture of sand and mud. That the species is remarkably rich in phosphate, however, seems to be clear; but it needs further investigation upon a better sample. In two of the *Gorgonias* the black, wiry axis was separately examined, although there was not enough of it for satisfactory analysis. In *G. suffruticosa* the axis lost on ignition 94.39%, and in *G. acerosa* 96.35%, mostly organic matter. The inorganic residues were small in amount, but partial analysis showed that they differed in composition from the more abundant calcareous envelopes. In some genera the axes are mainly calcareous; but in others the organic centers are very large, and the species are difficult to deal with analytically. Further investigation upon the differences in composition between cortex and axis is needed, but on biological rather than geological grounds. As the purpose of this investigation is to determine what each group

of organisms contributes to the formation of marine limestones, an extended study of their organic matter would be hardly relevant.

If, now, we arrange the alcyonaria in the order of ascending magnesium carbonate, a remarkable relation appears connecting composition with the temperature of the habitat. *Heliopora*, being anomalous, is not included in the table. *Alycyonium* is also excluded, on account of its impurities. The percentages of $MgCO_3$ and $Ca_3P_2O_8$ are both given.

Magnesium carbonate and calcium phosphate in alcyonaria.

SPECIES	LOCALITY	LATITUDE	$Ca_3P_2O_8$	$MgCO_3$
Primnoa reseda	Nova Scotia	42° 16′ N.	0.83	6.18
Lepidisis caryophyllia	Off Nantucket	48° 53′ N.	trace	6.92
Pennatula aculeata	Nova Scotia	44° 47′ N.	3.12	7.71
Paramuricea borealis	Grand Banks		1.43	8.03
Paragorgia arborea	Nova Scotia		0.56	9.05
Corallium elatior	Japan	33° N.	0.40	11.56
Tubipora purpurea	Singapore	1° 20′ N.	trace	12.23
Muricea echinata	C. San Lucas	22° 52′ N.	0.83	12.28
Gorgonia acerosa	Bahamas	25° 5′ N.	3.64	12.52
Muricea humilis	Brazil	7°–8° S.	0.59	12.64
Rhipidogorgia flabellum	Bermuda	32° N.	1.09	12.64
Xiphogorgia anceps	Florida	22° 30′ N.	1.96	13.04
Rhipidogorgia flabellum	Bahamaas	25° N.	2.80	13.19
Gorgonia acerosa	Florida	22° 30′ N.	2.87	13.29
Gorgonia suffruticosa	Fiji		0.47	13.43
Leptogorgia pulchra	L. California	24° 16′ N.	8.27	13.71
Plexaurella grandiflora	Brazil		trace	13.79
Leptogorgia rigida	C. San Lucas	22° 52′ N.	7.95	14.13
Ctenocella pectinata	Torres Straits	10° S.	0.88	15.65
Phyllogorgia quercifolia	Brazil	3° 50′ S.	8.57	15.73

Although records of temperature and depth of water are available for only a few of these alcyonaria, the suggested relation is clear. The organisms from cold, northern waters, or from very deep waters, are low in magnesia, while those from warm regions are much higher. The same relation appears in our analyses of echinoderms, and is unmistakable; even though it is as yet unexplained. It is not rigorously exact; but some apparent irregularities are due to the disturbing effect of impurities, such as sand or mud, which appear in the analyses as silica and sesquioxides. If these were rejected the percentage of magnesia would be raised. Variations are also to be expected because of cold or warm currents, and differing depths of water. Very deep water, even under the equator, is always cold; while shallow bays, even quite far north, may be relatively warm. Possibly also, the alcyonaria may form several distinct series, not perfectly comparable as regards chemical

composition. *Corallium* and *Tubipora*, for example, are compact forms, with little organic matter; and they are lower in magnesia than the genera with horny, organic axes, such as appear at the end of the table. It is also noteworthy that the highest proportions of calcium phosphate are commonly found associated with high values for magnesia.

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AN EXPERIMENTAL ANALYSIS OF THE ORIGIN AND RELATIONSHIP OF BLOOD CORPUSCLES AND THE LINING CELLS OF VESSELS

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Studies on the origin and development of the cellular elements of the blood and the so-called endothelial cells which line the blood vessels in the normal embryo are peculiarly difficult on account of the important rôle that wandering mesenchyme cells play in these processes. The problem is also further confused by the perplexing mixture of cells of different origin brought about by the early established circulation of the body fluids. The development of no other embryonic tissue is so disturbed by mechanical and physical conditions.

A study of living fish embryos with the high power microscope has made it possible to observe the behavior of the wandering cells and to follow them in their development. The disadvantages due to the intermixture of cells in the blood current have been overcome by the investigation of embryos in which a circulation of the blood is prevented from taking place.

When the eggs of the fish, Fundulus heteroclitus, are treated during early developmental stages with weak solutions of alcohol, the resulting embryos in many cases never establish a blood circulation. In other respects these embryos may be very nearly normal and the development and differentiation of their tissues and organs often proceed in the usual manner, though at a somewhat slower rate. The heart and chief vessels are formed and the blood cells arise and develop in a vigorous fashion. The heart pulsates rhythmically but is unable to propel the body fluid since its venous end does not connect with the yolk vessels. And in many cases its lumen is partially or completely obliterated by periblastic material and nuclei which seem to be sucked into the heart cavity from the surface of the yolk.

In these embryos without a circulation of the blood, one is enabled